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FLAVOUR CHANGING NEUTRAL CURRENT B DECAYS AT BABAR

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ABSTRACT

Recent BaBar results on rare B decays involving flavour-changing neutral currents are presented. New measurements of the CP asymmetries in $b \to s\gamma$ decays are reported as well as $b \to sl^+l^-$ branching ratio measurements[1].

1 Introduction

Since the first measurement of the exclusive $B \to K^*\gamma$ decay rate by CLEO [1], rare B decays involving flavour changing neutral current have been a unique probe to search for new physics. In the Standard Model (SM), the lowest order diagram for the $b \to s\gamma$ decay is a loop (radiative penguin) diagram of top quark and W boson. In principle, new particles such as charged Higgs or SUSY partners can form the same loop diagram and may modify the SM amplitude. A comparison between the measured rate and the SM prediction has provided a stringent constraint on such new particles. The inclusive decay is to date accurately calculated up to the next-to-leading order QCD corrections [2] and several measurements have already been performed. On the contrary, exclusive measurements, do not give a further constraint to new physics because of the large uncertainties in the form factors

[1]Charge conjugate modes will be assumed throughout this text

Table 1: *A_{CP} measurements in $b \to s\gamma$. Errors are statistics and systematics respectively.*

	$B \to K^*\gamma$	$B \to X_s\gamma$
Direct CP asymmetry A_{CP}	(-1.3 ±3 ±1)%	(2.5 ±5.0 ±1.5)%

computation. Other observables, such as the partial rate asymmetry (A_{CP}) between charge conjugate modes, could be more useful to constrain new physics. For example, the SM predicts very small asymmetry (≈1%)[3], while there are several extensions of the SM predicting much larger A_{CP}. Electroweak processes, like $b \to sl^+l^-$, are also useful probes for new physics searches. Expected rates are two order of magnitude smaller than for $b \to s\gamma$. At the lowest order, the decay is described by an electroweak (Z) penguin diagram and a W-box diagram in addition to the radiative penguin. If new particles with large weak bosons couplings exist, one can expect some additional contributions to $b \to sl^+l^-$ that are not visible in $b \to s\gamma$.

2 Measurements of CP Asymmetries in $b \to s\gamma$

The exclusive $B \to K^*\gamma$ analysis is detailed in [4]. The K^* is reconstructed in the four modes $K^{*0} \to K^+\pi^-, K^0_S\pi^0$ and $K^{*+} \to K^+\pi^0, K^0_S\pi^+$ and combined with a high energy isolated photon to form a B meson candidate. The background, mostly from continuum production, is suppressed by means of event topology variables. To reject events in which the photon comes from a $\pi^0(\eta)$ decay, a veto on $m_{\gamma\gamma}$ invariant mass is applied. The discriminating variables are the beam energy-substituted mass $m_{ES} = \sqrt{(E^*_{beam})^2 - (\vec{p}^*_B)^2}$ and the energy difference $\Delta E^* = E^*_B - E^*_{beam}$, where $\vec{p}_B$, E^*_B and E^*_{beam} denote the B-momentum, B-energy and beam energy in the center-of-mass (CM) frame, respectively. The signal yields are extracted from a likelihood fit to m_{ES} and ΔE. A "semi-inclusive" method, which measures a sum of exclusive $B \to X_s\gamma$ decays, is also used in BaBar [5]. The hadronic system X_s is reconstructed in 12 final states including a K^0_S or a K^+ and up to three pions (at most one π^0). The signal yields are extracted from a likelihood fit to m_{ES}. The results for the direct CP asymmetry, based on $81.9 fb^{-1}$, are reported in Table 1. These are consistent with zero and statistics limited.

3 Measurements of Branching Fractions in $b \to sl^+l^-$

The exclusive $b \to sl^+l^-$ measurement is described in [7]. Eight final states are reconstructed where a K^+, K^0_S, K^{*0} or K^{*+} recoils against a $\mu^+\mu^-$ or e^+e^- pair,

Table 2: *Branching Fractions (BF) Predictions and Measurements in $b \to sl^+l^-$ decays. Errors are statistics and systematics respectively.*

	$B \to Kl^+l^-$	$B \to K^*l^+l^-$	$B \to X_s l^+l^-$
BF Predictions ($\times 10^7$)	3.5 ± 1.2	11.9 ± 3.9	42 ± 7
Measured BF ($\times 10^7$)	$6.5^{+1.4}_{-1.3} \pm 0.4$	$8.8^{+3.3}_{-2.9} \pm 1.0$	$56 \pm 15 \pm 12$

using an integrated luminosity of 113.1 fb^{-1}. Specific selection criteria are used to suppress individual backgrounds. Event shape variables are used to eliminate the continuum background. To reject events from $B \to J/\psi(\psi(2S))K^{(*)}$ decays with $J/\psi(\psi(2S)) \to l^+l^-$, a veto on m_{ll} is applied. In each of the four $K^{(*)}l^+l^-$ final states, a signal is extracted from a fit to the $m_{ES}, \Delta E, (m_{k\pi})$ distributions. In the "semi-inclusive" approach [8], the reconstructed hadronic system X_s consists of one K^0_S or K^+ and up to two pions (at most one π^0). Background rejection is similar to the exclusive analysis. The signal yield is extracted from a likelihood fit to m_{ES} and the analysis is performed with an integrated luminosity of 81.9 fb^{-1}. The measured branching ratios are reported in Table 2 togheter with the theoretical predictions [6]. These results are in agreement with the SM predictions within the current level of accuracy and have errors comparable to the theoretical prediction precision. With larger data samples at the *B-factories*, it will be possible to make precise tests of the theoretical predictions for the differential distributions in these decays.

References

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